Global Alignment: field off, aligning along W

Updated from June 2 due to confusion in the plots/labels/inputs

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Outline

Outline

Updates

The alignment studies have been done using run3pp field-off data set. The changes between configurations are: the choice of which detectors to align, and the alignment corrections files.

This slides show:

- similar studies to the ones presented few weeks ago (2nd of June), but
- at that time some inconsistancies were found out in the plots (by Vince!), and investigating more, some inconsistancies have been found in the simulation files too.
- All studies have been redone, giving reliable results now.

Comparaison with MinJung corrections

- MinJung came with corrections for station 2 mainly. So the first study had been made aligning station 2, to be in the same configuration as MJ. Results showed that aligning with Millepede gave a slightly better track quality.
- Now, the alignment has been run for **all** stations of the MuTr in order to see if Millepede's alignment improves.

Comparaison with AuAu corrections (MJ + Pat + Melynda)

- For AuAu analysis, new corrections were made over MinJung's ones, especially concerning station 2 (north) and the MuID. Those new corrections, which will be called AuAu corrections, were found studying run4 field on data.
- To compare Millepede's corrections with AuAu ones, MuTr station 2 and the MuID have been aligned. Since the global alignment has only been validated on field-off data, **run3pp field-off data** will be reconstructed with AuAu corrections and compare with the corrections found by Millepede aligning station 2 MuTr and the MuID of the same data set.

Outline

Run3 field-off - comparing with MinJung alignment

- The following plots compare the alignment: for station 2 MuTr with MinJung's corrections, Millepede's corrections, and for all mutr with Millepede's corrections.

- The plots present the mean value of the residuals distributions for each detector in the MuTr, as well as their sigmas. This is an indicator of the tracks quality.

- Note: to avoid global geometrical transformations, gap0, station0 and station1 are fixed when aligning all MuTr. An attempt will also be made to fix gap1, station1 instead.

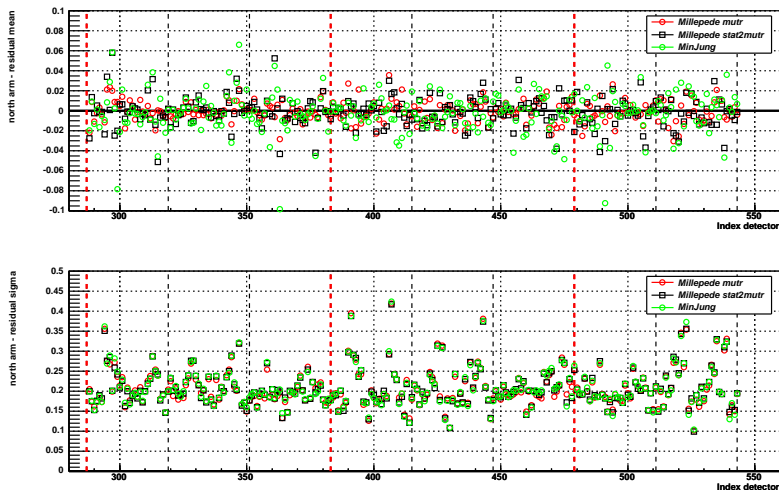# South arm residuals - Run3 field off data
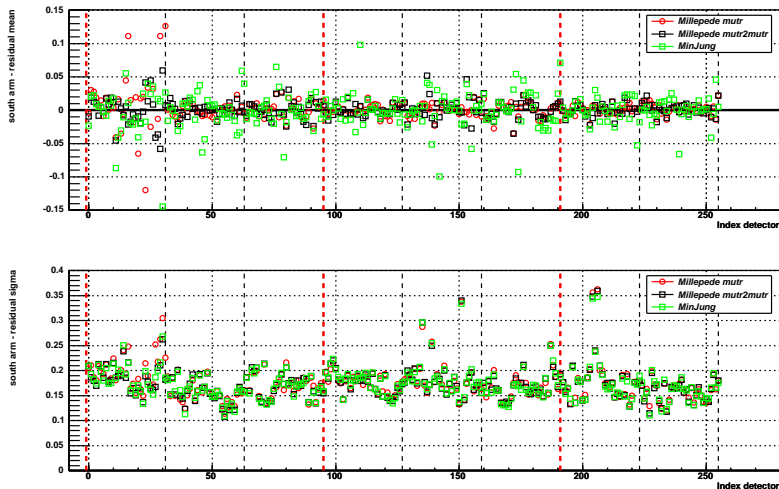
Top graph: residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm. **Bottom graph:** sigma of the residuals vs detector index. **Red:** whole MuTr aligned with Millepede; **black:** MuTr station 2 aligned with Millepede; **green:** MinJung corrections.

Comments: Aligning with Millepede gives residuals more centered than when aligning with MinJung's corrections. The resudials aligning all MuTr are slignthly better than with station2 MuTr only, except for station0, gap0. This gap is the one fixed in this study. Algining with another fixed gap instead should help in the understanding of such a behavior.
The residuals sigmas are almost identical because they are dominated by the resolution of the detector and statistics.
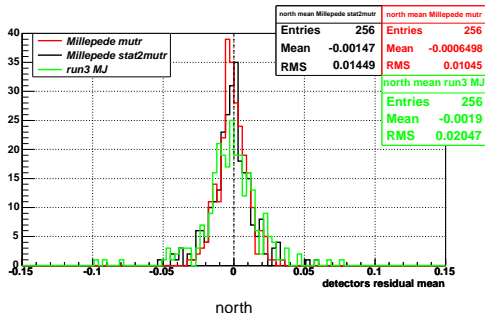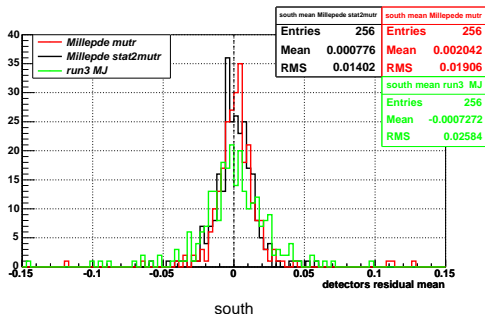
Red: whole MuTr aligned with Millepede; **black:** MuTr station 2 aligned with Millepede; **green:** MinJung corrections.

Comments: The sigmas look the same.
Aligning with Millepede is better than aligning with MJ, and better with all the MuTr. Less improvement than in the south but the strange behavior in gap 0 station 0 is not seen for north arm. Note that the scale is smaller for north residuals means than south (because of the first gap strange behavior in south).

# Residuals means' projection - Run3 field off data

south

north

Legend: The histograms are the projection of the previous graphs means (top ones) on the y axis.

- red Millepede, whole MuTr;
- black: Millepede, MuTr station2;
- green: using MinJung's corrections.

Comments: Narrower distributions when Millepede is used for the whole MuTr $\implies$ the detectors are better aligned on average.

South arm residuals with another gap fixed
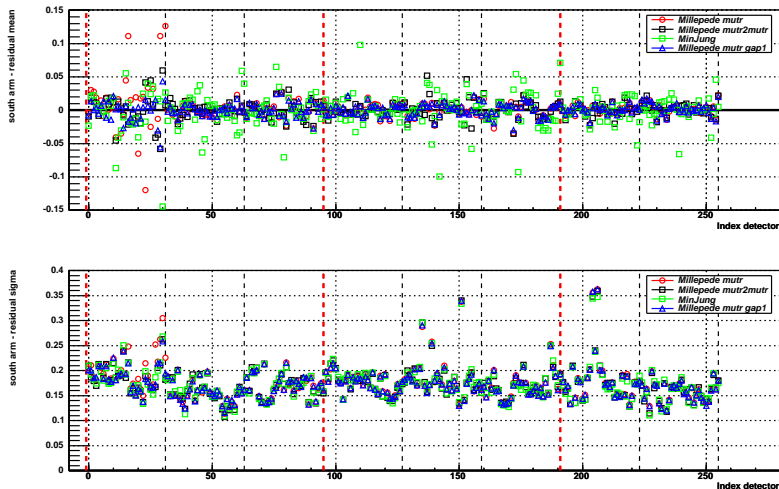
Top graph: residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm.**Bottom graph:** sigma of the residuals vs detector index. **Red:** whole MuTr aligned with Millepede; **black:** MuTr station 2 aligned with Millepede; **green:** with MinJung corrections; **blue:** whole MuTr aligned with Millepede's corrections, gap fixed are: station 0, gap1 and station1, gap0.

Comments: Changing the fixed gap in station 0 from gap 0 in red to gap 1 in blue helps the improvement of the residuals in this station. The alignment with the whole mutr, new gap fixed, is better than any other.

North arm residuals with another gap fixed
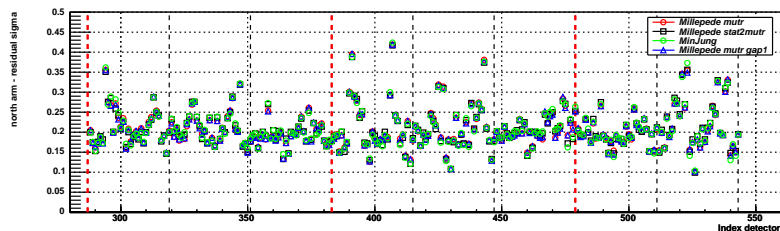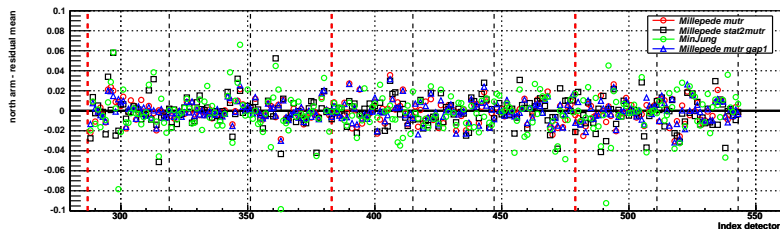
Comments: The alignment is event better with the new set of fixed gaps, aligning all MuTr. Some cathodes have bigger RMS for the residuals $=>$ study them more carefully ?

Residuals means' projection with other gap fixed
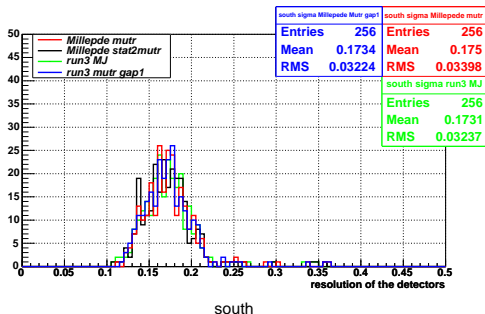

south

north
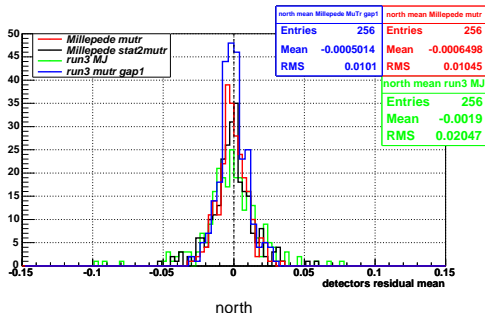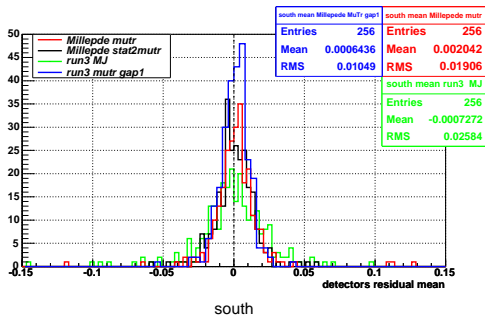
Legend: The histograms are the projection of the previous graphs means on the y axis.

- red Millepede, whole MuTr;
- black: Millepede, MuTr station2;
- green: using MinJung's corrections.
- blue: Millepede, whole MuTr, other gap fixed in station 0.

Comments: Narrower distributions when Millepede is used for the whole MuTr other gap fixed in station 0 $=>$ the detectors are better aligned on average.

Residuals sigma' projection with other gap fixed

south

north

Legend: The histograms are the projection of the previous graphs sigmas on the y axis.

- red Millepede, whole MuTr;
- black: Millepede, MuTr station2;
- green: using MinJung's corrections.
- blue: Millepede, whole MuTr, other gap fixed in station 0.
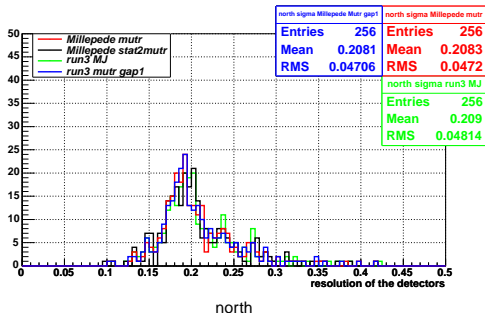
Comments: The sigmas are almost the same for all configurations: the resolution of the detector and the statistics dominate the residuals sigmas.

Outline

Run3 field-off - comparing with AuAu alignment

- The following plots compare the alignment of station 2 MuTr and MuID with run3 field-off data set, using AuAu corrections (MinJing + Pat + Melynda) and Millepede's corrections. Aligning the whole mutr with gap1 in station0 fixed (and gap0, station1) and the muid has also been tryed.

- Since both MuTr station 2 and MuID were aligned and the resolution of the two are quite different, the plots show results for the 2 detectors separatly. An improvement of the quality of the tracks should be seen on both mutr and muid residuals.

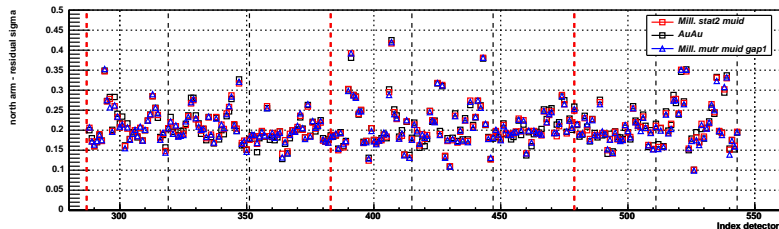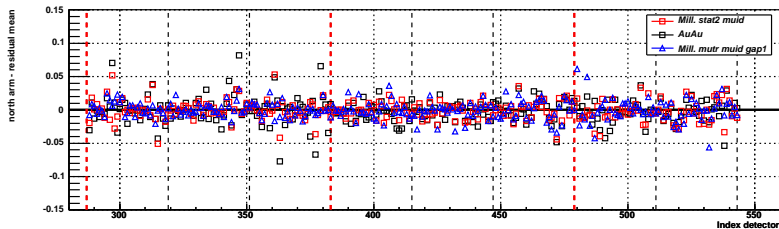# Residuals MuTr south - run3 field off data
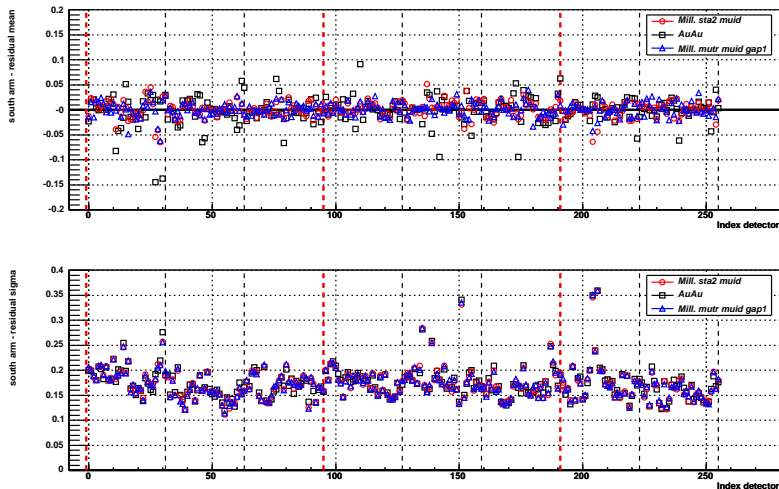
Top graph is the residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm. **Bottom graph** is the sigma of the residuals vs detector index. **In red** results using Millepede's corrections aligning only MuTr station 2 and the MuID; **in black** are the results aligning with AuAu corrections; **in blue** all the MuTr and the MuID were aligned with Millepede's corrections.

Comments: For south arm, the residuals sigmas look the same for both configurations. Millepede's residuals are more centered than with AuAu corrections, and even better aligning all the MuTr.
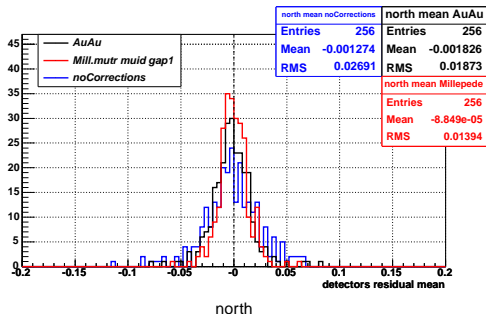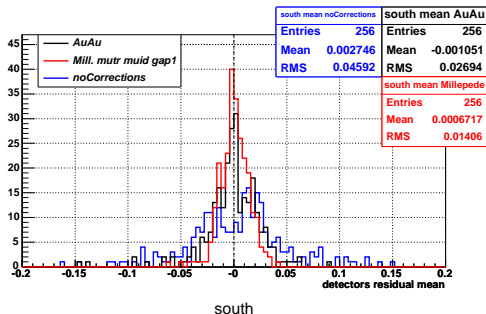
Residuals MuTr north - run3 field off data

Comments: The residuals means for Millepede's results are slightly better than with AuAu corrections.

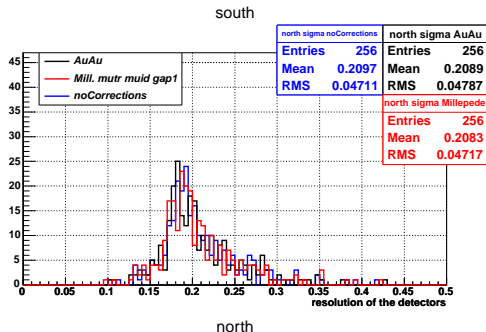# Residuals means' projection MuTr - run3 field off data
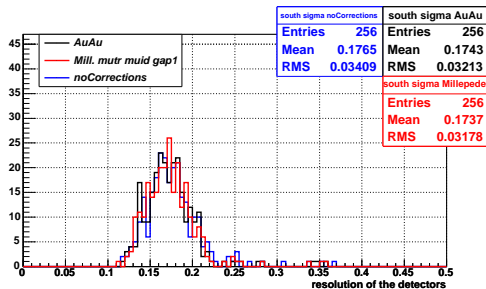

south

north

Legend: The histograms are the projection of the previous graphs means on the y axis.

- black: AuAu corrections;
- red Millepede, aligning MuTr and MuID;
- blue: no corrections.

Comments: For both north and south arm, the residuals means projection is tighter around 0 when aligning with Millepede's corrections. This shows that the alignment with Millepede improves the reconstruction over the other configurations.

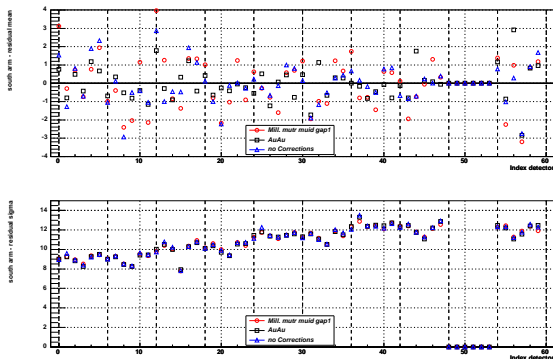# Residuals sigma' projection MuTr - run3 field off data

south

north

Legend: The histograms are the projection of the previous graphs sigmas on the y axis.

- black: AuAu corrections;
- red Millepede, aligning MuTr and MuID;
- blue: no corrections.

Comments: The sigmas are more are less all the same.

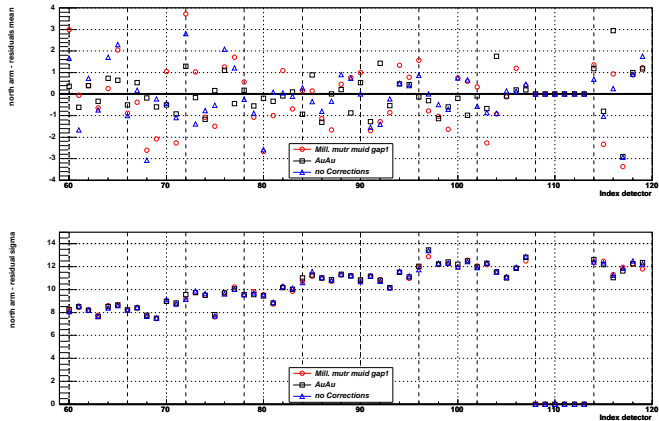# Comparing residuals for south MuID

Top graph: residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm. **Bottom graph:** sigma of the residuals vs detector index. **In red**: results using Millepede's corrections from aligning the MuTr and the MuID; **in black** results aligning MuTr station2 and MuID with AuAu corrections; **in blue** results without corrections.

Comments: The RMS are too big to conclude anything. Plane 4 seems to have no hits probably because of the HV that might have been turned off for those runs.

On the whole, results seem to be better without corrections than with AuAu corrections, and even worse with Millepede's corrections. This is strange given the well behavior of the MuTr alignment with Millepede as seen previously. Ideas to look at:

- Do the MC really show improvement for the MuID ? (underway)

- Do the fit of the straight tracks include the MuID properly ?

- Are we looking at good roads, or do the cut selection keep contamination ?

- Do we have enough statistics to align with Millepede or are the error bars too big from Millepede's alignment ?

Comparing residuals for north MuID
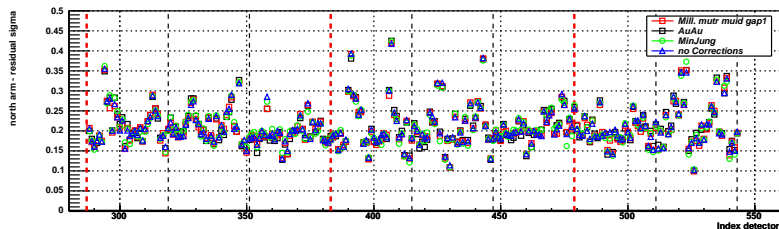

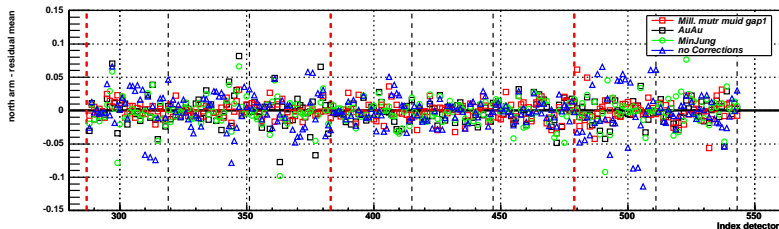**Comments:** Same comments.

Outline

MuTr residuals south - AuA vs MJ vs Mill. vs Nothing

Top graph is the residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm. **Bottom graph** is the sigma of the residuals vs detector index. **In red** Millepede aligning MuTr (fixed: stat0gap1, stat1gap0); **in black** are the results aligning with AuAu corrections; **in green** MJ corrections on station2 MuTr; **in blue** no corrections.

Comments: Alignment improved with MinJung corrections, even more with AuAu corrections, and more with Millepede.
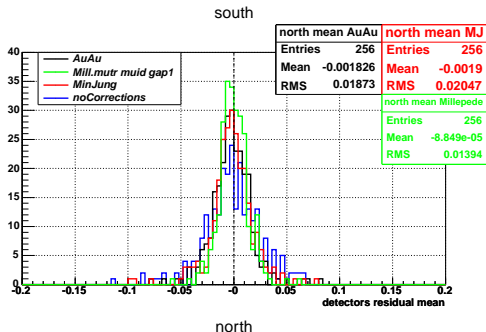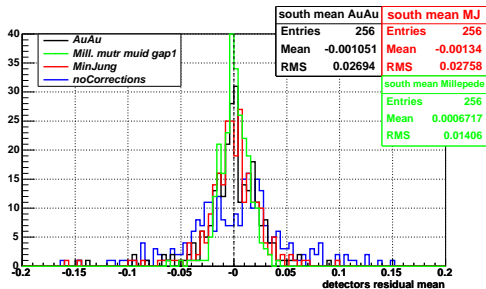
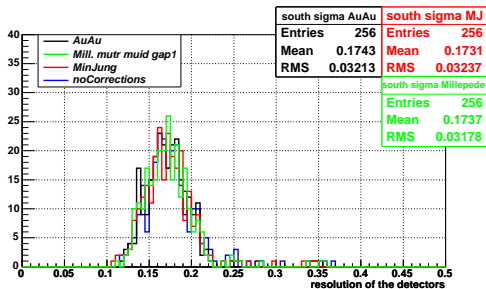# Residuals MuTr north - AuAu vs Mill. vs MJ vs Nothing

Same comments

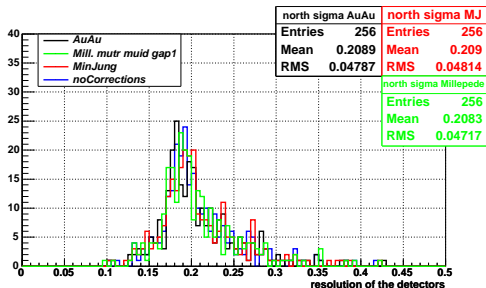# Means MuTr - AuAu vs Mill. vs MJ vs Nothing

south

north

Legend: The histograms are the projection of the previous graphs means on the y axis.

- black: AuAu corrections;
- red: with MinJung corrections;
- green: Millepede, aligning MuTr and MuID.

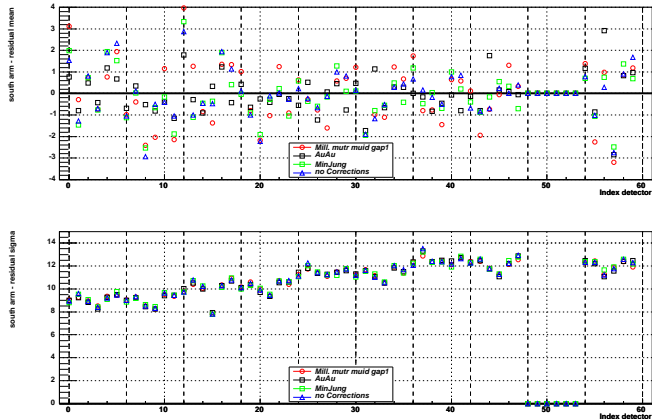# Sigma MuTr - AuAu vs Mill. vs MJ vs Nothing

south

north

Legend: The histograms are the projection of the previous graphs sigmas on the y axis.

- black: AuAu corrections;
- red: with MinJung corrections;
- green: Millepede, aligning MuTr and MuID.

**Comments:** The sigmas are more are less all the same.

MuID residuals south - AuA vs MJ vs Mill. vs Nothing

Top graph: residual mean value vs detector index (left to right is first to last station). The ordinate is the mean in cm.
Bottom graph: sigma of the residuals vs detector index. **In red** results using Millepede's corrections; **in black** is the results aligning MuTr station2 and MuID with AuAu corrections; **in blue** results without corrections.

Comments: Still the same strange behavior of the sopposly aligned muid: the more corrections are put, the more the residuals get worse.

MuID residuals north - AuA vs MJ vs Mill. vs Nothing
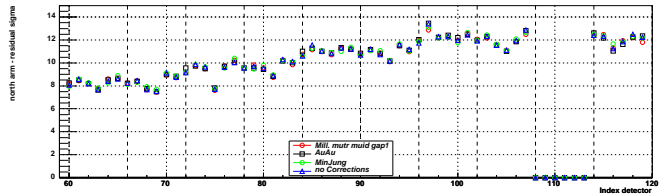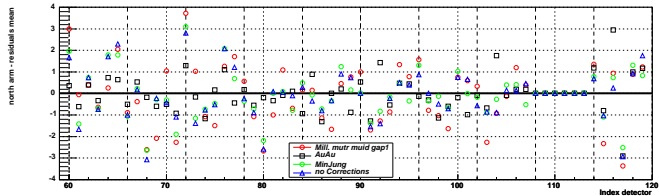
Comments: Same comments.

Outline

Conclusions

Global alignment status:

- Millepe aligns well the MuTr when running on field-off data.
- Tests are underway to validate the MuID alignment.

Todo list:

- Run the method on Run6 at CCF.
- Start writing a technical note.
- Field on:
    1. look at Millepede corrections on field on data: can systematic misalignments be seen when turning the field ON ?
    2. put the MuID in the kalman fit to align with field on, MuTr and MuID.
- Phi and Z parameters have been left aside to validate some steps of the method. Should be studied in more details to see if W and Phi are really correlated in a way that the alignment is not possible with more parameters (more statistics wuth run 6 should help).